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Forecasting high-tech ASVAB scores

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by

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THESIS

FORECASTING HIGH-TECH ASVAB SCORES

by

Ellen E. Moreau

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ABSTRACT

The development of a model for estimation of a high-tech market population will help determine an efficient allocation of recruiting resources. Using data from the National Longitudinal Survey of Youth (NLSY), regression equations were developed to estimate the probability that a 17 to 21 year old high school graduate will score high enough on the Armed Services Vocational Aptitude Battery (ASVAB) to be classified into a high-tech rating. This probability is modeled as a function of sociodemographic variables including gender, race/ethnicity, parents' education, poverty status, income, residence in an urban area, and receipt of welfare payments. The results should facilitate calculations of nationwide, county-level, high-tech market distributions.

TABLE OF CONTENTS

LIST OF TABLES

I. INTRODUCTION

Since the end of conscription in 1973, the military has been faced with several problems in trying to maintain a fighting force capable of defending our national security. Two obstacles manpower officials have been confronted with are the changes in the American youth population, and the increasing need for high-quality recruits to satisfy the surge in high-tech positions and ratings.

A decline in the qualified military available (QMA) population has been forecast to last through the mid-1990s. Reaching a projected low by 1995, the population will start an increase that should last through the year 2010. However, the increase in the QMA population will not be in the same proportion as the increase in total population. This occurrence may be due to shifts in the socioeconomic mix of the population through changing fertility rates among different groups and the influx of non-White immigrants into the country. THE QMA is projected to increase by 10.6 percent by 2010, which may ease, but most likely will not alleviate recruiting problems. (Thomas, 1990)

Although the current draw-down of the military labor force by 25 percent would appear to ease the recruiting requirements, the need for personnel capable of working with technology may actually increase. Labor economics theory

indicates that one way to decrease labor without negatively impacting productivity is through the substitution of capital. This capital may well be in the form of increased technology. Therefore, the military will have to continue to compete with the civilian labor force and universities to attract the quality youth that will be capable of utilizing this technology.

The United States Military was one of the first to use aptitude testing to indicate the potential a person has to meet occupational requirements (Eitelberg, 1988). The Army designed several tests during World War II that were intended for use by (1) personnel managers, to have an objective way of assigning new recruits, and (2) military commanders, to have a standard measure of the ability of their men. These types of tests, in particular the Armed Services Vocational Aptitude Battery (ASVAB) and the Armed Forces Qualifications Test (AFQT), are still being used today to assign people to the training required for designation into certain ratings.

The research question asked in this thesis is "what factors and individual characteristics 'best' predict high-tech qualification scores." Additional questions include: (1) what constitutes the term high tech, (2) what model specification is most appropriate, (3) what variables might be useful in predicting high-tech qualification scores, and (4) what are the specific equations that best predict whether an

individual will score well enough on the ASVAB to be assigned to a high-tech rating.

Since the type of equations developed in this thesis need to be able to be utilized for predicting the high-tech market on a local geographic region (county) level, only those variables for which data are available nationwide at the county level were considered. Since the model is intended to be predictive rather than causal, determining the independent effects of each explanatory variable is of secondary importance. The problems of multi-collinearity in causal modeling will therefore be of less concern.

II. LITERATURE REVIEW

Several important factors affect the demand and supply of recruits eligible for technical training: the changing youth population, technological advances in the military aptitude tests, and the current world situation.

A. THE CHANGING YOUTH POPULATION

Following the end of World War II, an increase in the birthrate of the United States was seen from 1946 through 1964 and according to Webster's College Dictionary, is known as the "baby boom". However, in the late 1950s a reverse trend in the birthrate started and lasted until the mid-1960s. Bowman, Little and Sicilla (1986) noted that this generation, known as the "birth dearth" or "baby bust", passed through the nation's educational system and first started completing high school in 1983. It was at this time that the military began to feel the real impact of this decline. The military had traditionally tried to attract 18-to-21 year-old volunteers, and was in direct competition with civilian labor force and post-secondary schools. The impact of the decline in youth can be seen in Table I, shown below, which was taken from "The All-Volunteer Force After a Decade".

TABLE I
PROJECTED U.S. POPULATION AGED 18 TO 21, BY SEX AND RACE, SELECTED YEARS, 1981-95 (in thousands)

Category	1981	1983	1985	1987	1989	1991	1993	1995
MALE	8,618	8,356	7,821	7,356	7,404	7,197	6,702	6,608
White	7,281	7,010	6,509	6,085	6,089	5,864	5,405	5,331
Black	1,147	1,145	1,102	1,053	1,070	1,071	1,022	994
Other	190	201	210	218	236	262	275	283
Female	8,401	8,142	7,821	7,164	7,197	6,984	6,494	6,386
White	7,059	6,799	6,312	5,896	5,897	5,666	5,220	5,137
Black	1,168	1,161	1,116	1,067	1,081	1,076	1,022	994
Other	174	182	193	201	219	242	253	259
Total	17,019	16,498	15,442	14,520	14,601	14,181	13,197	12,994

Source: William Bowman, Roger Little, and G. Thomas Sicilla, The All-Volunteer Force After A Decade: Retrospect And Prospect. Mclean, Va: Pergamon-Brassey's International Defense Publishers. 1986, p. 90. Figures are rounded.

As indicated in Table I, by 1995 the male 18-to-21 year-old cohort is expected to decrease to 6.6 million, roughly 13 percent below the 1986 level. After that, the youth cohort should begin to rise again and continue to grow until at least 2010. This is called the "echo effect" and is not due to increases in fertility rates but rather to the fact that women born during the "baby boom" have reached their childbearing years. These numbers will start to decrease again during the 1990s, when women from the baby boom generation begin leaving their active childbearing years.

Binkin (1986) also notes that another contributor to the changing youth population is the anticipated shift in the

social composition of the American population. Two factors will cause minority groups to make up a greater proportion of the youth population: (1) a higher fertility rate among minority women in the resident population, and (2) the concentration of non-Whites among new immigrants to the United States.

Estimates of changes in the youth population are shown in Table II. The top panel shows the social shift attributable only to changes within the resident population, notably between social or ethnic groups. Fertility rates among White women have traditionally been lower than for Black women. However, between 1970 and 1975 the fertility rate[1] for White women decreased from 2,338 to 1,685 while the rate for Black women decreased from 2,949 to 2,185. An important note is that a rate of 2,100 is need for a population to replace itself in the long run. Calculating fertility rates for Hispanic women is more difficult, but the Population Reference Bureau estimates the rate is roughly eleven percent higher than that of Black women. (Binkins, 1986)

Projections for post-1980 immigrants aged 15 through 19 and their descendants are contained in the middle panel. There is a great deal of controversy over future immigration

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[1]The total fertility rate is defined as live births per 1000 women. It indicated the number of children that women would have in their lifetime if, at each year of age, they experienced the age-specific birth rates occurring in a specified year (Binkins, 1986).

TABLE II
PROJECTED U.S. MALE POPULATION AGED 15 TO 19, BY RACIAL OR ETHNIC GROUP, SELECTED YEARS, 1980-2000

Number in thousands	1980		1985		1990		1995		2000	
Category	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Resident population	**10,751**	**100.0**	**9,297**	**100.0**	**8,495**	**100.0**	**8,289**	**100.0**	**9,390**	**100.0**
White	8,234	76.6	7,021	75.5	6,267	73.8	6,032	72.8	6,780	72.2
Black	1,488	13.8	1,341	14.4	1,247	14.7	1,213	14.6	1,525	16.2
Hispanic[a]	826	7.7	745	8.0	778	9.2	840	10.1	895	9.5
Asians and other[b]	203	1.9	190	2.0	203	2.4	204	2.5	190	2.0
Immigrants[c]	...	...	**110**	**100.0**	**207**	**100.0**	**289**	**100.0**	**370**	**100.0**
White	...	...	22	20.0	41	19.8	58	20.1	72	19.5
Black	...	...	12	10.9	23	11.1	32	11.1	41	11.1
Hispanic	...	...	35	31.8	66	31.9	92	31.8	122	33.0
Asian and other	...	...	41	37.3	77	37.2	107	37.0	135	36.5
Total population	**10,751**	**100.0**	**9,407**	**100.0**	**8,702**	**100.0**	**8,578**	**100.0**	**9,760**	**100.0**
White	8,234	76.6	7,043	74.9	6,308	72.5	6,090	71.0	6,852	70.2
Black	1,488	13.8	1,353	14.4	1,270	14.6	1,245	14.5	1,566	16.0
Hispanic	826	7.7	780	8.3	844	9.7	932	10.9	1,017	10.4
Asian and other	203	1.9	231	2.5	280	3.2	311	3.6	325	3.3

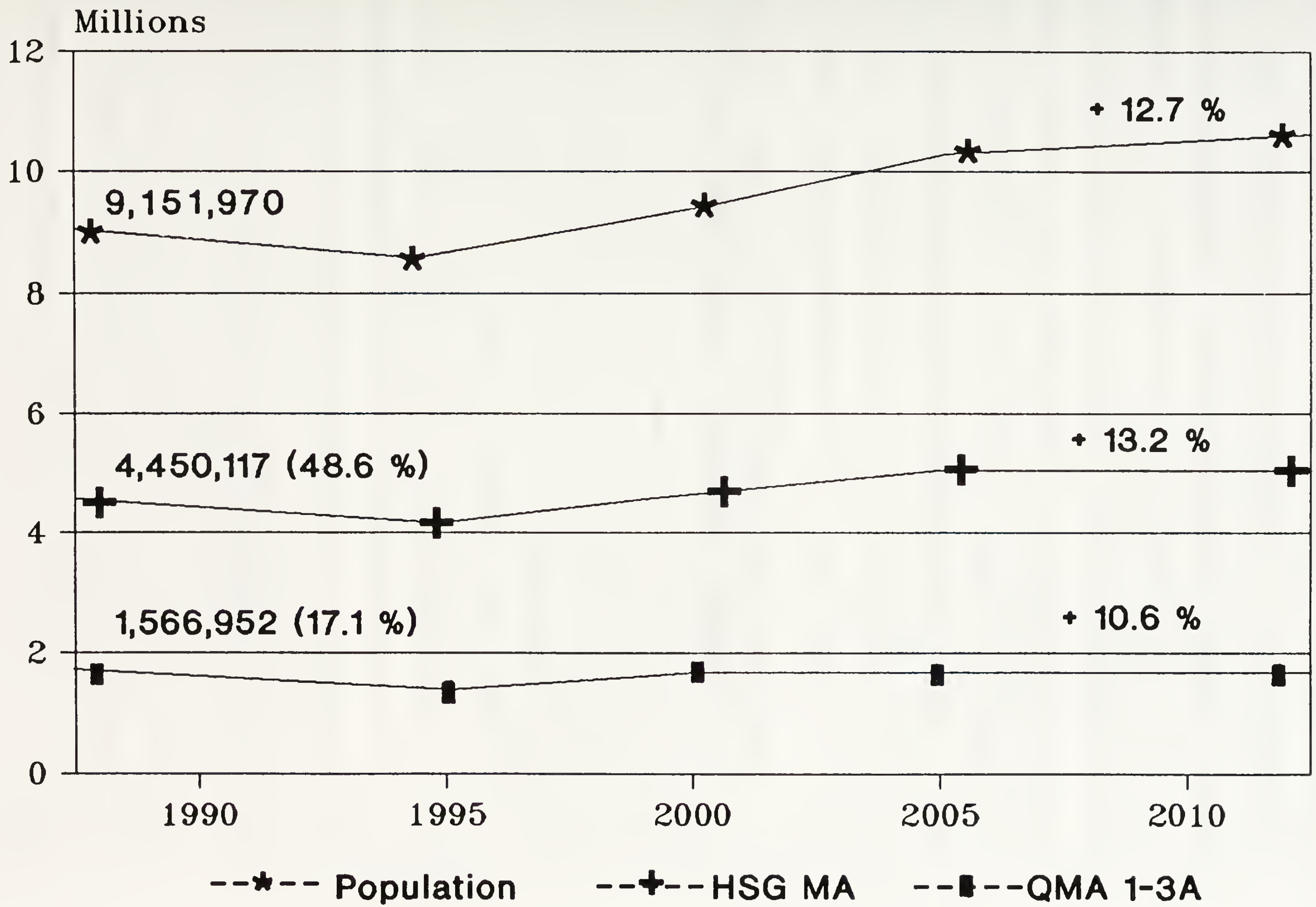
Source: Martin Binkin, Military Technology and Defense Manpower, Washington, D.C.: The Brookings Institute, 1986 pg. 65.

a. Hispanics can be of any race.
b. Includes all people who did not indicate any other racial category listed in the Census questionnaire.
c. Includes post-1980 immigrants and their descendants.

estimates with wide ranges being given. The estimates in this table roughly approximate the experience in the early 1970s, and are based on annual immigration limits of 500,000.

The bottom panel shows total population effects, which indicate a total population decline for 15-19 year-olds through the mid-1990s. After that, the population will start to rise, but there will be a continued decrease in the proportion of White males. The number of young males expected to qualify for military service will be affected, since Blacks and Hispanics have historically been less successful than Whites at meeting educational and aptitude requirements for entry. The graph on the following page, taken from Thomas, "High Quality Recruiting Markets", illustrates the projected trends in the male, 17-to-21 year-old population through the year 2010.

POPULATION/MA*/QMA



Males, 17–21

B. MILITARY TECHNOLOGY

The growth of technology within the military has taken place from the very beginning of the nation. The U.S. has come a long way from the days of wooden sailing ships and Minutemen with muskets. At the same time, the composition of the military has had to change. The wage of today's service member is of a highly trained specialist, and the majority of service personnel are trained on the highly advanced weaponry that now makes up the U.S. arsenal (Eitelberg, 1988). Binkin, as shown in Table III, indicates that over the time between the end of World War II and 1985, White collar jobs in the

TABLE III
DISTRIBUTION OF TRAINED MILITARY ENLISTED PERSONNEL BY OCCUPATIONAL AREA, SELECTED YEARS, 1945-85

Percent					
Occupational Area[a]	1945	1957	1963	1973	1985
White-collar	28	40	42	46	47
Technical workers[b]	13	21	22	25	29
Electronics	8	13	14	18	21
Other	7	8	8	7	8
Administrative and clerical workers[c]	19	19	20	21	18
Blue-collar	72[d]	60	58	60	53
Craftsmen[e]	29	32	32	28	27
Service and Supply workers	17	13	12	13	10
General Military Skills Including combat	24	15	14	13	16

Source: Martin Binkin, Military Technology And Defense Manpower, Washington, D.C.: The Brookings Institute, 1986, p. 6. Percentages are rounded.

a. Categories are based of the Department of Defense occupational classification system.

b. Percentages before 1973 consist of "electronics" and "other technical" categories. Percentages for 1973 and 1985 consist of "electronic equipment repair," "communications and intelligence specialists," "medical and dental specialist," and "other technical and allied specialist" categories.

c. Percentages before 1973 are for the: "administrative and clerical" category. Percentages for 1973 and 1985 are for the "functional Support and administrative" category.

d. Includes 2 percent classified as miscellaneous.

e. Percentages before 1973 consist of "mechanics and repairmen" and "craftsmen" categories. Percentages for 1973 and 1985 consist of "electrical/mechanical equipment repairers" and craftsmen" categories.

military climbed to 29 percent, an increase of 16 percentage points from 1945. Technical workers in the military climbed to 29 percent, an increase of 16 percentage points from 1945.

Bruce E. Arlinghaus states in a collection of articles edited by Taylor, Olson, and Schrader (1981) that while military technology has advanced at a rapid pace and given the U.S. "an edge" over militaries of other nations, the improvement in soldier quality has not been in proportion to the technological innovation in weapons development. "Put another way, our soldiers are not too dumb; rather, our weapons have become too smart."

Since the last two world wars, there has been a pronounced tendency in the Department of Defense to seek technological solutions for difficult defense problems. The American "industrial might" has been called upon to permit U. S. military forces to expend firepower rather than manpower on the battlefield. However, despite the technological superiority of new systems, they are still dependent upon the humans operating them -- a factor sometimes ignored in both their design and anticipated employment. Arlinghaus notes that several key problems present themselves in the design and procurement processes. First, defense designers often do not take into account either the mental and physical limitations of the personnel expected to operate and maintain the equipment or the conditions under which the equipment might be used. Second, if "average" soldiers are expected to operate

the equipment, the "average" soldier should be used to test the equipment, not hand-picked, superior soldiers. Third, during testing periods the equipment should be maintained by the military personnel who would normally be responsible for maintenance, rather than "tech reps" from the development company that are experts on the system. Fourth, once the system has been adopted, live fire exercises should be conducted for as many of people who will use the weapon as possible. Finally, strategic planners should incorporate realistic combat effectiveness goals for these new systems into force planning and wargaming.

C. APTITUDE TESTING

Over the past decade, the military has been trying to improve the quality of the force by stressing the need for recruiting volunteers who fall in the upper 50th percentile of the AFQT. In Table IV, a breakdown of scores for the AFQT is shown with the corresponding level of trainability.

In a study done by Byrnes and Marcus (1988) on Navy student quality and training success, it was shown that high school graduates in technical training who were also in mental in categories I-IIIa had a pass rate more than four percent better than those who were in the lower mental categories. (Byrnes and Marcus, 1988) Students in the upper categories were 4.2 to 6.4 percent less likely to face academic attrition those in the lower categories. Thus, it is simply more efficient to bring in the higher mental category volunteers.

TABLE IV
ARMED FORCES QUALIFICATION TEST (AFQT) CATEGORIES
BY CORRESPONDING PERCENTILE SCORES AND LEVEL OF "TRAINABILITY

AFQT CATEGORY	AFQT PERCENTILE SCORE	LEVEL OF TRAINABILITY
I	93-99	Well above average
II	65-92	Above average
IIIA	93-99	Average
IIIB	31-49	Average
IV	10-30	Below Average
V	1-9	Well below average

Source: Mark J. Eitelberg, Manpower For Military Occupations, Office or the Assistant Secretary of Defense (Force Management and Personnel), 1988 p. 74.

They may cost more to recruit and enlist, but the difference in cost is maded up through savings in training dollars.

While the AFQT represents the minimum level of aptitude required for basic enlistment, not every recruit can or will be assigned to a job requiring only the bare minimum qualifications. Recruits must also be matched with available occupations that have separate, often higher, minimum standards. If a recruit has met the basic enlistment requirements, but fails to meet the minimum score for an available job or has not scored sufficiently high for any career field he is willing to enter, then he may have his enlistment delayed or denied.

Between the 1950s and the early 1970s, the military services used a variety of aptitude tests. In 1974, the Department of Defense decided that all of the services should use a single test battery and the Armed Services Vocational

Aptitude Battery was selected. Implementation began in 1976. This test was already being used by the Air Force and the Marine Corps and today remains the main test battery for screening and job assignment for all of the services. Each of the services uses the ASVAB in different ways to classify their personnel. Table V gives a breakdown of the subtests within the battery.

Eitelberg (1988) observes that while the standards for basic enlistment have often been raised or lowered in reaction to recruiting demands, changes to the service's minimum requirements for job assignment do not normally occur. These occupational standards have been held constant in order to maintain long-run stability in the overall force as well as continuity in training programs and job staffing.

Since most recruits can meet the minimum standards for a number of jobs, the recruiter's job is to influence the potential enlistee to take a job for which he is neither over qualified nor minimally qualified. Because the military wishes to fill its ratings with the highest caliber personnel available, if it has more than one recruit trying for a position, the highest score will be taken. Therefore, if a recruit really wants an assignment that he is minimally qualified for he may have to compete with other recruits for that position. The ideal mix for the military is to find a job that matches an individual's aptitude as well as his desire and personality characteristics.

TABLE V
ARMED SERVICES VOCATIONAL APTITUDE BATTERY (ASVAB) SUBTESTS: DESCRIPTION, NUMBER OF QUESTIONS, AND TESTING TIME

ASVAB Subtests Title and Abbreviations	Description	Number of Questions	Testing Time (minutes)
General Science (GS)	Measures knowledge of physical and biological sciences	25	11
Arithmetic Reasoning (AR)	Measures ability to solve arithmetic word problems	30	36
Word knowledge (WK)	Measures ability to select the correct meanings of words presented in context and to identify the best synonym for a given word	35	11
Paragraph Comprehension (PC)	Measures the ability to obtain information from written passages	15	13
Numerical Operations (NO)	Measures ability to perform arithmetic computations in a speeded context	50	3
Coding Speed (CS)	Measures ability to use a key in assigning numbers to words in a speeded context	84	7
Auto and Shop Information (AS)	Measures knowledge of automobiles, tools, and shop terminology and practices	25	11
Mathematics Knowledge (MK)	Measures knowledge of high school mathematics principles	25	24
Mechanical Comprehension (MC)	Measures knowledge of mechanical and physical principles and ability to visualize how illustrated objects work	25	19
Electronics Information (EI)	Measures knowledge of electricity and electronics	20	9
All Subtests		334	144[a]

Source: Mark J. Eitelberg, Manpower For Military Occupations, Office or the Assistant Secretary of Defense (Force Management and Personnel), 1988, p. 68.

Note: Subtests are in ASVAB Forms 8, 9, 10. Information also applies to ASVAB Forms 11, 12, and 13, as well as 14 (used in the DOD student testing Program), ASVAB subtests appear here in the order in which they are administered.

[a]Administrative time is approximately 36 minutes, for a total testing and administrative time of 3 hours.

In his study of population eligibility for occupational assignment. Eitelberg (1988) developed a "qualification rate" by first screening individuals using the basic enlistment standards and then applying occupational qualification standards. This qualification rate was then used to study differences in ASVAB performance between males and females and between Whites, Blacks and Hispanics.

He noted that since the ASVAB is a "vocational aptitude battery" and stresses technical skills as well as mathematical, mechanical, and electronic competence, there are a majority of subtests that favor test performance of men over women. Even on the subtests that do favor women, such as coding skill and paragraph comprehension, the degree of advantage for the women is not as great as the advantage men have on the majority of the other subtests. This results in female applicants experiencing more difficulty in qualifying for many military jobs, especially for the high-tech jobs.

Although the gender differences are significant, they are not as dramatic as those between Whites and minorities, specifically between Whites and Blacks. The following findings underscore the fact Blacks consistently have much lower qualification rates that their White counterparts: (1) within the four respective services, there are proportionately more Whites who can qualify for the **most** selective jobs than Blacks of the same gender who can qualify for the **least** selective jobs (2) for the Administrative, General, and

Electronics composites,[2] there are proportionately more White women who can qualify for the **least** selective jobs, and (3) the proportions of Blacks who would be able to pass minimum standards for most selective jobs of any type, in any service, are usually under ten percent and often much lower. The situation for Hispanics is consistently better than for Blacks, but there is still a significant difference Whites the same gender.

D. WORLD SITUATION

Over the past two years, the world has changed dramatically and the military establishment has been turned upside down. First came the demise of the Cold War and the downgrading of the Soviet Union as the threat it once was. This brought with it a desire by the American public and Congress to benefit from the so-called "peace dividend". Plans were made by Congress to cut the defense budget and shift the money to domestic programs that the public was clamoring for. Congress called for a twenty-five percent reduction in the size of military personnel to take place by 1995.

In the second year of the force reduction a crisis presented itself. On August 2, 1990, Iraq, a one-time ally and recipient of financial and military assistance from the United States, invaded and overtook Kuwait, a smaller, neighboring country. The United States was immediately called upon by the Kuwaitis to assist them in regaining their

country's freedom and then by the Saudi Arabians to protect their country from an invasion by the same attacker. On the same day as this attack, Secretary of Defense Cheney was outlining to the Senate Armed Services Committee the revised force structure called for by the reduction of the military.

Since its inception in 1973, the All-Volunteer Force had never really been tested in a full-scale battle. There were opponents of the All-Volunteer Force who questioned the quality of the personnel and whether or not all the "fancy" weapons the military bought would work adequately during actual combat. With the invasion of Kuwait and the subsequent Operations Desert Shield and Desert Storm, the All-Volunteer Force was given its first major, albeit brief, test. Although many military manpower analysts have reserved comment on whether or not this really tested the quality of military personnel, few will deny that this crisis tested the weapons systems currently in use. The consensus is that "high tech" works. A related conclusion might be that, if the high-tech weaponry worked, then the people working the weapons must have performed.

How will this victory affect the future? Predictions can be made for both sides that this war will help or hinder recruiting. Confidence in the military has risen considerably. The military appears to have shaken off the bad image from the Vietnam era. However, the war has also served to remind possible volunteers that the military is not

strictly a peacetime institution. The possibility of going to war is very real. The Gulf War may have a considerable and unpredictable effect on recruiting efforts for the next several years.

III. THEORETICAL MODEL, METHODOLOGY AND DATA

Previous work has been done relating various sociodemographic characteristics to performance on tests of mental ability. Research done by Peterson (1990) explored the relationship of test performance on the AFQT to various factors including gender, race, educational achievement, family structure and background as well as parental achievements. He concluded that parents' education, poverty status, and urban residence are good predictors of mental ability. This thesis extends that research to determine what impact these factors have on an individual's ability to pass the qualification criteria for a Navy high-tech job classification.

In order to maintain a quality fighting force, the U.S. military has concentrated its recruiting efforts on what it considers to be the "prime market" -- high school graduates, 17 to 21 years of age who score in the upper 50th percentile on the AFQT. Out of this high quality recruitment pool, a proportion is selected to fill positions that are considered to be highly technical, skilled, positions.

A. DATA

The National Longitudinal Survey of Youth (NLSY) was the data set used for modeling performance on high-tech entry criterion. The NLSY is an extension of the National

Longitudinal Surveys of Labor Market experience initiated by the Office of Manpower Policy, Evaluation and Research of the United States Department of Labor in the mid-1960s.[2] In 1977, the Department of Labor decided to begin the NLSY for two reasons: (1) to replicate the analysis of previous youth cohort studies, and (2) to evaluate expanded employment and training programs for youth legislated by amendments to the Comprehensive Employment and Training Act (CETA). A national probability sample was drawn consisting of three groups: a cross-section of American young people 14 to 21 years old as of January 1, 1979, in their proper population proportions; (2) a supplemental oversample of civilian Hispanic, black, and economically disadvantaged whites in the same age range; (3) a military sample of 17 to 21 year olds who were serving in the military as of September 30, 1978.[3] The NLSY is weighted in order to compensate for the unequal probability of selection. (NLS Handbook, 1990)

During 1980, in order to obtain current data on the vocational aptitudes of youth and to update national norms, the Armed Services Vocational Aptitude Battery (ASVAB) was administered to NLSY respondents. Of the original 12,686 NLSY respondents, 11,914 actually took the test, a 94 percent

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[2]The Department of Labor contracted the Center for Human Resource Research (CHRR) of Ohio State University to conduct these studies.

[3]In this research, "white" refers to all non-black, non-Hispanic individuals.

completion rate. Until this point, test norms were still based on World War II data. The military portion of the sample took the ASVAB a second time rather than having their enlistment ASVAB scores used. To begin the research for this thesis, the data set was partitioned to represent the "prime market." The 22-to-23 year-olds were also kept in the sample, since they are still recruitable, to evaluate what effect age has on test performance. Only those 17-to-23 year-olds who held a high school degree (not a GED or equivalent) prior to the 1981 NLSY interview were retained. Those who received their degree after that were assumed to be off of the normal education track.

The sample was then divided into six subgroups: (1) white males (WM); (2) white females (WF); (3) black males (BM); (4) black females (BF); (5) Hispanic males (HM); (6) Hispanic females (HF). These subgroups are consistent with the distinctions recruiting officials often make in setting recruiting goals. According to Peterson (1990), differences among the mean AFQT scores and percentages scoring above the 50th percentile are also significant between those groups.

B. NAVY HIGH-TECH RATINGS

To be able to use this data to estimate the high-tech market, a definition of high-tech be established. For this purpose, the Office of the Commander, Naval Recruiting Command was asked to provide a list of Navy ratings that were

considered to be "high-tech". The following table contains these ratings.

TABLE VI
NAVY HIGH-TECH RATINGS

GROUP ONE	**MK+EI+GS = 156 +AR = 218**
AQ[a]	Aviation Fire Control Technician
AT	Aviation Electronics Technician
AX	Aviation Antisubmarine Warfare Technician
ET	Electronics Technician
EW[a]	Electronics Warfare Technician
FC[a]	Fire Control Technician
IC(SUB)[a]	Interior Communications Electrician
STG[a]	Sonar Technician
GROUP TWO	**2MK+AR+GS = 196 TO 214**
AC	Air Traffic Controller
AE	Aviation Electrician's Mate
AG	Aerographer's Mate
AW[a]	Antisubmarine Warfare Operation
EM	Electrician's Mate
OTA	Ocean Systems Technician (Analyst)
GROUP THREE	**AR+MK+GS+EI = 204**
GM[a]	Gunner's Mate
GSE[a]	Gas Turbine System Technician (Electrical)
GSM[a]	Gas Turbine System Technician (Mechanical)
IC	Interior Communications Electrician
GROUP FOUR	**VE+AR+NO+CS =202**
CTI	Cryptologic Technician (Interceptive)

[a] Currently closed to women

The 18 ratings fall into groups that correspond to four qualification formulas. These formulas take various ASVAB

subtest scores and combine them to give a predictor of potential ability. The four formulas are defined below.[4]

Group One MK+EI+GS = 156 +AR = 218	Mathematics Knowledge (MK) + Electronics Information (EI) + General Science (GS) = 156 Arithmetic Reasoning (AR) = 218
Group Two 2MK+AR+GS = 196 to 214	2 * Mathematics Knowledge (MK) + Arithmetic Reasoning (AR) + General Science (GS) = 196 to 214
Group Three MK+EI+GS+AR = 204	Mathematics Knowledge (MK) + Electronics Information (EI) + General Science (GS) + Arithmetic Reasoning = 204
Group Four VE+AR+NO+CS = 202	Verbal (VE)[a] + Arithmetic Reasoning (AR) + Numerical Operations (NO) + Coding Speed (CS) = 202

Verbal = Word Knowledge (WK) + Paragraph Comprehension (PC)

A correlation analysis was conducted on the four group formulas as well as on the formulas and each of the ASVAB subtests to determine if any one formula could substitute for another or if any subtest could substitute for a formula. When the actual cut score restrictions are removed from the formulas and only the subtest combinations are examined, group one and group three's formulas become the same. The results, illustrated in the following table, show that the first three groups are highly correlated. The fourth group was not highly correlated with any of the others due to the emphasis on language skills. While the subtests that were part of each formula were highly correlated, none of them dominated

[4]Appendix A contains the process for converting raw scores t standardized scores for use in calculating the rating cut scores

TABLE VII
CORRELATION TABLE OF HIGH-TECH GROUPS

	GROUP 1&3	GROUP 2	GROUP 4	AFQT
GROUP 1&3	1.000	.967	.825	.919
GROUP 2	.967	1.000	.839	.929
GROUP 4	.825	.839	1.000	.914
AFQT	.919	.929	.914	1.000

enough to consider using only that subtest score.[5]

A frequency analysis was then conducted to determine what proportion of the NLSY prime market respondents would pass each of the four qualification scores. The following table shows that if an individual is in the prime market, he stands a good chance of being able to qualify for the second and third groups.[6] However, the first and fourth groups show dramatic decline in the number of people that were able to pass the cut score. Another interesting observation is the difference between males and females being able to meet the qualification scores. Females were able to qualify over eighty percent of the time in only Group Two. Females

[5]Appendix B contains the correlation table for the ASVAB subtests.

[6]The percentages for the second group are based on the group's lowest cut score of 196. Some of the ratings in this group have higher cut scores and would thus have lower percentages if each rating within the group was evaluated separately.

TABLE VIII
HIGH-TECH MARKET PERCENT OF PRIME MARKET

MALES				
RACE	**GROUP 1**	**GROUP 2**	**GROUP 3**	**GROUP 4**
WHITE n=1,685	74%	98%	93%	77%
BLACK n=145	40%	89%	74%	47%
HISPANIC n=137	51%	96%	82%	66%
FEMALES				
RACE	**GROUP 1**	**GROUP 2**	**GROUP 3**	**GROUP 4**
WHITE n=1,357	29%	91%	64%	77%
BLACK n=115	6%	84%	34%	49%
HISPANIC n=88	19%	83%	50%	65%

qualified at approximately the same rate as males in Group Four; however Groups One and Three showed declines of 20-30 percent by females.

Using this information, a decision was made about which group best represented the high-tech market needs of the Navy. Group Four was discounted since it relies heavily on language skills and only represents one rating. Group one was chosen as the one that best represents the Navy's high-tech needs since: (1) it contains more personnel, and (2) it contains a cross-section of ratings from all three of the warfare communities.

C. EXPLANATORY VARIABLES

Previous research indicates that there is a strong positive relationship between mother's education and performance on the ASVAB. The same positive relationship should be present for performance on high-tech entrance qualifications. However, the maximum value of parents' education[7] is used in this thesis for three reasons: (1) it helps reduce the relatively large number of missing values for mother's education, (2) it performs as well as mother's education in explaining performance, and (3) county-level data similar to this measure are more readily available.

General socioeconomic status was represented in the model by the proxy variable poverty status. This variable is expected to have a negative effect on high-tech criterion performance. Another indicator of socioeconomic status is net family income which was expected to have a positive effect on test performance.[8]

Since the data set contained over 800 individual 22-to-23 years-old an exploration on the influence of age on ASVAB test performance was considered useful. A dummy variable was included separating the "prime market" 17-to-21 year-olds from

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[7]When an observation was missing one of the parent's education information, the other parent's education was used as the average education.

[8]Since the variable for net family income in 1980 has a large number of values, net family income for 1979 or 1981 was substituted when needed. These income values were then deflated to 1982-84 dollars using the Consumer Price Index.

the 22 and 23 year olds. Age was expected to have a positive effect due to the additional experience or schooling an individual may gain as he grows older. However, that expectation can be countered by the observation that some skills that are tested heavily in the ASVAB, such as math, begin to deteriorate over time if not used. To capture such effects as the quality of schools and educational opportunities the individual may have experienced, a dummy variable for living in an urban area is included. This variable is expected to have a negative effect for minorities since such individuals are more likely to attend inner-city schools with marginal educational opportunities. A better variable would be one that would directly reflect the quality of school that the person attended, however the NLSY does not contain a variable of this kind.

In summary, the explanatory variables chosen for investigation include: (1) parent's education; (2) poverty status; (3) net family income; (4) age; and (5) whether or not the individual lived in an urban area.[9]

The logit model shown below was specified for this analysis:

$$\ln[P_i/1-P_i] = a + b\underline{X}_i + u_i$$

where P_i = the probability that individual i

[9]Appendix C contains a list of all variables used during this research.

scores above high-tech cut score[10]

$1-P_i$ = the probability of individual i not

scoring above the high-tech cut score

$\underline{X}_i$ = a vector of individual i's

sociodemographic characteristics

u_i = a random error term

The logit model has several important features: (1) as X_i increases, $P_i = E[Y=1[X]$ increases but never steps outside the zero to one interval, and (2) the relationship between P_i and X_i is non linear.

[10]The high-tech cut score used here is MK + EI + GS = 156 + AR = 218 as required by group one.

IV. MODEL ESTIMATION

A priori expectations of the composition of each subgroup are confirmed by comparisons of the means of the variables among the subgroups as seen in Table IX. A point to remember about these mean comparisons is that all of the individuals being examined are in the I-IIIA categories of the AFQT. The percentage of whites passing the high-tech cut score is the highest followed by Hispanics and then Blacks. When each racial subgroup is further divided by gender, the percentages of females able to pass the high-tech criterion are dramatically lower than for males 30.0%, 6.8% and 20.3% for White, Black and Hispanic females as compared to 75.5%, 43.2% and 51.4% for White, Black and Hispanic males respectively. Average parents' education for Whites and Blacks exceeds the 12 year level followed by Hispanics with approximately 10 years. All of the subgroups had less than ten percent of the people in them in poverty except for Black females at fifteen percent. Mean family income levels were also consistent with the findings for poverty status. A smaller proportion of whites are in the 17-to-21 year old age range than were blacks and Hispanics.

TABLE IX
MEANS OF EACH SUBGROUP BY VARIABLE

	WM n=1,685	WF n=1,357	BM n=145	BF n=115	HM n=137	HF n=88
17-21	72.1%	73.7%	76.3%	82.9%	85.7%	73.9%
In poverty	8.8%	9.6%	8.5%	15.9%	9.5%	8.7%
PAR ed.	12.7%	12.7%	12.6%	12.5%	10.2%	10.5%
Income	8635.0	8258.9	7808.4	7442.3	8681.6	7420.9
In urban	65.4%	68.1%	69.5%	79.5%	88.6%	85.5%
Tech qual'd	75.5%	30.0%	43.2%	6.8%	51.4%	20.3%

The logit regression equations for males and females presented in Table X were calculated using the LOGIST procedure contained in release 5.16 of SAS. Additional logit regressions were run on each racial subgroup. However, due to the limited sample of high-tech qualified individuals in the Hispanic and Black female subgroups these regressions are not reported.

The primary criterion used for selecting the "best" model was goodness of fit measured by the percentage of individuals properly categorized as above or below the high-tech cut score and the model R statistic. Parsimony and theoretical consistency were also considered.

TABLE X
HIGH-TECH MODEL RESULTS

MALES				
Variable	**Coefficient**	**Std. Error**	**Chi^2**	**P-Value**
Intercept	.153	.294	0.27	<.6043
Black	-1.410	.198	50.69	<.0001
Hispanic	-0.799	.219	13.35	<.0003
Age (17-21=1)	-0.455	.138	10.85	<.0010
Parents' Ed.	0.103	.022	20.97	<.0001
Poverty	-0.006	.201	0.00	<.9766
Income	-0.7×10^{-5}	$.8\times10^{-5}$	0.61	<.4333
Urban	0.125	.126	0.99	<.3208

Model Chi-Square = 106.63

R = .218

Percent Correctly Predicted = 73.3

FEMALES				
Variable	**Coefficient**	**Std. Error**	**Chi^2**	**P-Value**
Intercept	-1.829	.353	26.89	<.0001
Black	-1.670	.429	15.09	<.0001
Hispanic	-0.279	.315	0.79	<.3755
Age (17-21=1)	-0.446	.141	10.03	<.0015
Parents' Ed.	0.098	.026	13.69	<.0002
Poverty	-0.100	.222	0.20	<.6517
Income	$.7\times10^{-5}$	$.9\times10^{-5}$	0.64	<.4255
Urban	-0.069	.142	0.23	<.6291

Model Chi-Square = 54.33

R = .161

Percent Correctly Predicted = 72.6

The coefficient signs for black and Hispanic are negative for both models and were significant with the exception of

Hispanic in the female model. This confirms *a priori* expectations that non-whites have historically had more difficult time passing the criterion for classification to a high-tech rating.

The age variable is coded as a dummy variable with 17-to-21 year-olds equal to one and 22-to-23 year-olds equal to zero. Being in the 17-to-21 age range had a negative effect on ASVAB performance. This may be explained by the additional schooling or experience an individual may gain as he ages. These factors were not controlled for in this study.

Consistent with previous research done on AFQT scoring ability, parents' education has a strong positive effect on the probability of scoring above the high-tech cut score.

The prior expectations of the socioeconomic variables were confirmed only in part. Poverty status had a negative effect in each model as expected; however, the effect was not significant in either model. The coefficient of the income variable was expected to be positive, but this was only true in the female model. The negative effect expected from urban residence was present in only the female model. Neither the income nor the urban residence variable were significant in any model.

An analysis of the partial effects of the variables was conducted. A basecase was constructed for each racial subgroup with the following qualities: 17-to-21 years-old, not in poverty, living in an urban residence with the mean net

family income and the mean average parent's education of and respectively. The following tables show the estimated probability of being in the high-tech market was for each basecase group. A wide variation can be seen between

TABLE XI (A-F)
PROBABILITY OF BEING IN THE HIGH-TECH MARKET

A. WHITE MALE		
	Prob.	**Change**
Basecase	.742	----
22-23 yrs. old	.819	.0773
Poverty	.741	-.001
Rural	.717	.025
Parents' Ed + 1 yr.	.761	.019
B. BLACK MALE		
	Prob.	**Change**
Basecase	.185	----
22-23 yrs. old	.263	.078
Poverty	.184	.001
Rural	.166	.018
Parents' Ed + 1 yr.	.201	.016

TABLE XI (A-F) CONT.

C. HISPANIC MALE		
	Prob.	**Change**
Basecase	.294	----
22-23 yrs. old	.397	.102
Poverty	.293	-.001
Rural	.269	.025
Parents' Ed + 1 yr.	.280	.022
D. WHITE FEMALE		
	Prob.	**Change**
Basecase	.262	----
22-23 yrs. old	.355	.094
Poverty	.242	.019
Rural	.274	.013
Parents' Ed + 1 yr.	.280	.019

TABLE XI (A-F) CONT.

E. BLACK FEMALE		
	Prob.	**Change**
Basecase	.020	----
22-23 yrs. old	.030	.011
Poverty	.019	-.001
Rural	.021	.001
Parents' Ed + 1 yr.	.021	.002
F. HISPANIC FEMALE		
	Prob.	**Change**
Basecase	.074	----
22-23 yrs. old	.112	.038
Poverty	.068	.007
Rural	.079	.005
Parents' Ed + 1 yr.	.081	.007

the basecase for white males and other males and an even more dramatic difference between white males and any female subgroup. These tables show that white males have an almost 75 percent chance of being able to qualify for high-tech classification while other males and white females have less than a 30 percent chance of qualifying. Each subgroup is negatively afffected when switched into a poverty status,

however only males are effected by being switched into a rural residence. Black and Hispanic females have less than a 10 percent chance of qualifying. Each subgroup is positively affected being in the 22-23 year old category and by having parents with an additional year of education.

V. CONCLUSIONS

Three separate conclusions can be drawn from this thesis. First and foremost is the conclusion that equations for high-tech eligibility can be estimated. Secondly, that market composition (i.e. socioeconomic status, race, gender) systematically affects the proportion of the high quality market that will qualify for high-tech ratings. Thirdly, acceptable regional measures can be used to capture this variation.

Research had been done previously in the area of AFQT scores, but little research had focused specifically at high-tech qualified people. It is especially important to the military, now in the midst of a drawdown, to be able to predict where the best markets are for these high quality individuals. This thesis demonstrates that estimations can be done for these markets.

Membership in high-tech market is affected by the same type of socioeconomic factors that influence whether or not an individual is in the upper 50th percentile of the AFQT. Factors contributing the most influence were race, age and parent's educational achievement. Other factors maintained in the model specification included poverty status, residential location and income. Theses factors lead to the third

conclusion that variables are available on a regional level via information obtained through the U.S. Census Bureau.

Further research is being done on the development of measures of interest in the military (attitudes about being in the military) for the high-tech market.

APPENDIX A

CONVERSION OF RAW ASVAB DATA TO STANDARDIZED SCORES

ASVAB standardized scores are obtained through a conversion process using a linear transformation using a mean of 50 and a standard deviation of 10. (Peterson, 1990) Transformations are based on data collected through the Profile of American Youth using the weighted population of 18 to 23 year old males and females. The formula used to transform a raw subtest score into a standard score (SSS) is as follows:

$$SSS = (10/S) \quad (NC-X) + 50,$$

where

SSS = the standardized subtest score (round this result to the nearest integer: if it is less than 20 then raise it to 20 and if it is greater than 80 then lower it to 80)

S = the standard deviation of the subtest scores (see Table A1 for this value for each subtest)

NS = the number of questions answered correctly for the given subtest (for Verbal this is the sum of the number answered correctly for Word Knowledge and Paragraph Comprehension)

X = the mean of the subtest raw scores (see Table A1 for each subtest)

TABLE A-1
ASVAB SUBTEST MEANS AND STANDARD DEVIATIONS

ASVAB	ABBREVIATION	MEAN	STANDARD DEVIATION
General Science	GS	14.7	5.3
Arithmetic Reasoning	AR	18.0	7.4
Word Knowledge	WK	24.3	8.5
Paragraph Comprehension	PC	10.2	3.7
Numerical Operations	NO	32.4	11.6
Coding Speed	CS	43.5	17.0
Auto/Shop Information	AS	13.1	5.6
Mathematics Knowledge	MK	13.6	6.4
Mechanical Comprehension	MC	13.0	5.4
Electronics Information	EI	10.6	4.4
Verbal	VE	37.3	10.6

The means and standard deviations were taken from the NLSY data set prior to partioning it down to the prime market.

APPENDIX B
CORRELATION TABLE OF ASVAB SUBTESTS

	AR	GS	EI	AS	MC	MK
AR	1.00	.682	.758	.999	.751	.473
GS	.682	1.00	.777	.682	.713	.700
EI	.758	.773	1.00	.758	.750	.606
AS	.999	.682	.758	1.00	.751	.472
MC	.751	.713	.750	.751	1.00	.617
MK	.473	.700	.606	.472	.617	1.00
NO	.376	.563	.469	.376	.451	.630
CS	.334	.514	.422	.334	.409	.541
PC	.512	.725	.633	.511	.576	.668
WK	.608	.825	.721	.608	.643	.689
VE	.602	.826	.721	.601	.647	.709

	NO	CS	PC	WK	VE	AFQT
AR	.376	.334	.512	.608	.602	.744
GS	.563	.514	.726	.825	.826	.867
EI	.469	.422	.633	.721	.721	.970
AS	.376	.334	.511	.608	.601	.743
MC	.451	.409	.576	.643	.647	.743
MK	.630	.541	.668	.689	.709	.765
NO	1.00	.720	.638	.641	.667	.669
CS	.720	1.00	.609	.601	.629	.616
PC	.638	.609	1.00	.819	.909	.940
WK	.641	.601	.819	1.00	.983	.956
VE	.667	.629	.909	.983	1.00	.970

APPENDIX C

TABLE C-1
YOUTH NATIONAL LONGITUDINAL SURVEY (NLSY)

VARIABLES USED IN DATA ANALYSIS

Variable Number	Variable Description and Survey Year
R19 (1979)	With Whom did respondent Live at Age 14
R65	Highest Grade Attended by Mother (1979)
R79	Highest Grade Attended by Father (1979)
R96	Racial/Ethnic Origin (1979)
R182	Does Respondent Have High School Diploma or Equivalent (1979)
R183	Which does Respondent Have, High School Diploma or GED (1979)
R2148	Sex of Respondent (1979)
R2179	Total Net Family Income (1979)
R2202	Age of Respondent (1980)
R2299	Does Respondent Have High School Diploma or Equivalent (1980)
R2300	Which does Respondent Have, High School Diploma or GED (1980)
R4060.10	Total Net Family Income (1980)
R4181	Does Respondent Have High School Diploma or Equivalent (1981)
R4182	Which Does Respondent Have, High School Diploma or Equivalent (1981)
R6150	ASVAB Subtest Raw Score; General Science (1980)
R6151	ASVAB Subtest Raw Score; Arithmetic Reasoning (1980)
R6152	ASVAB Subtest Raw Score; Word Knowledge (1980)
R6153	ASVAB Subtest Raw Score; Paragraph Comprehension (1980)
R6154	ASVAB Subtest Raw Score; Numerical Operations (1980)
R6155	ASVAB Subtest Raw Score; Coding Speed (1980)
R6156	ASVAB Subtest Raw Score; Auto and Shop Information (1980)
R6157	ASVAB Subtest Raw Score; Mathematics Knowledge (1980)
R6158	ASVAB Subtest Raw Score; Mechanical Comprehension (1980)
R6159	ASVAB Subtest Raw Score; Electronics Information (1980)
R6148.10	Total Net Family Income (1981)
R6185	Family Poverty Status in 1980 (1981)

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